REMARKS/ARGUMENTS

Claims 1-84 remain pending in the instant Application. Claims 1-39, 63-75, 77 and 81-84 are withdrawn from consideration pursuant to Examiner's restriction requirement and Applicant's subsequent election.

Amendments to the Claims

Claim 40 is amended to restore the word "outlet" in the final line thereof, erroneously omitted in the previous amendment. The final line of claim 40 now reads "fluid, near the reactor <u>outlet</u> in at least one of the transverse directions." (underline per 37 C.F.R. § 1.121) This amendment is fully supported in the original specification as filed, and no new matter has been added.

Claim Objections

Claim 43 was objected to for an informality of language. The claim is amended above as prescribed by the Examiner.

Claims 47 and 48 were objected to for lack of antecedent basic in the tern "the hot fluid". These claims are amended above to recite --reaction product-- in place of "hot fluid". Antecedent basis for "reaction product" can be found in claim 40, and no new matter ahs been added.

Claim 55 is objected to for lack of antecedent basic in the terms "the fuel" and "the oxidant". As amended above, these terms have been replaced by "the reactant" and "the co-reactant", respectively. Antecedent basis for these terms can be found in claim 40, and no new matter ahs been added.

Favorable reconsideration and withdrawal of the objections is kindly requested.

Rejections Under 35 U.S.C. § 103

Claims 40-42,45,46 49-58, 61, 62, 76, and 78-80 are rejected under 35 U.S.C. § 103(a) as obvious over U.S. Patent No. 4,273,527 to) Meenan ("Meenan") in view of U.S. Patent No. 4,483,137 to Faulkner ("Faulkner"). Applicant respectfully traverses the rejection.

Independent method claim 40 recites, in part

> ...configuring a reactor; the reactor having a streamwise curvilinear fluid flow direction and a first and second transverse directions mutually distinct from the streamwise flow direction, the first and second transverse directions defining a surface through a reactor location transverse to the flow...

Independent method claim 76 recites in part

> ...configuring a reactor; the reactor having a streamwise fluid flow direction and a first and second transverse directions mutually distinct from the flow direction, the first and second transverse directions defining a surface through a reactor location transverse to the flow;
>
> ...
>
> wherein controlling the at least one spatial distribution of the co-reactant fluid and the diluent fluid in at least one of the transverse directions; and
>
> wherein controlling at least one of the composition, temperature, pressure and velocity of the reaction product, in at least one transverse direction near an outlet of the reactor taken in the surface along a direction transverse to the flow.

The Office Action alleges that these features are taught by Meehan. Applicant respectfully disagrees. The Office Action states at Para. 15 (p. 5) "the reactor (10) having a streamwise curvilinear fluid flow direction (see Meenan, fig. 1) (showing a curved delivery path for delivery of reactants) and a first and a first [*sic*] and second transverse directions (see Meenan, Fig. 1) (e.g., the first direction being parallel to the central axis of the reactor (10)."

The reactor "streamwise curvilinear fluid flow direction" as taught in the instant disclosure comprises direction of primary reactor flow comprising second fluid flow, as well as first fluid, third fluid, and products of combustion. Claims 40 and 76 include " first and second transverse directions mutually distinct from the streamwise flow direction, . . ." Consequently, "first and second transverse directions" have components transverse to the reactor streamwise flow direction and are not along it.

With reference to Meenan, Applicant respectfully submits that Meenan in Fig. 2 (as detailed in Fig. 1) shows a cylindrical "Top Hat" combustion chamber 28. The combustion chamber 28 is surrounded by a cylindrical refractory housing 46 with a closed end holding jets 42, 44 and 47 that axially deliver liquid fuel and/or pulverized fuel. Air or oxidant fluid is introduced into chamber through peripheral tubular conduits 12 having radially inward jet openings 26. The gas and oxidant flows through orifices 26 and 30 are circumferentially constrained by the combustor refractory housing 46. Flows through orifices 26 and 30 are

further axially constrained by the end wall. Consequently, the primary fluid flow (e.g., combined air, and gas, liquid fluid, or pulverized fuel, and combustion gas) must eventually flow out through the open end of the "Top Hat" cylindrical combustor, i.e., axially along the direction parallel to the axis of the combustor chamber 28. Upstream of the combustor outlet, by symmetry, cylindrical constraint and end constraint, the primary fluid flow near the axis is along the axial direction towards the combustor outlet. Further from the axis, the primary direction will still be curvilinear tending towards the axial direction and distinct from the radial injection of gas and air through orifices 26 and 30.

Referring to Meenan Fig. 1, Applicant identifies arrows or lines point to reactor 10, combustion chamber 28, gas and air orifices 26 and 30. Fig. 1 further shows fluid flow arrows from manifold 14 into perforated tubes 12A and fluid flow arrows from manifold 22 into perforated tubes 18B, etc. In Meenan Fig. 2, Applicant identifies a corresponding arrow to combustion chamber 28, orifices 47 and fluid arrow showing water flow out of tube 38. Applicant further sees the axial fluid flow arrows in liquid jets 42 and 44, and the axial fluid flow arrow for pulverized fuel in 47, with corresponding predominantly axial fluid flow lines out of those jets within the combustion chamber 28. With respect, Applicant does not find any indication of Meenan teaching in Fig. 1 of "a curved delivery path for delivery of reactants" that results in "the first direction being parallel to the central axis of the reactor".

While Meenan teaches gas and air being directed radially into the combustor 28 through orifices 26 and 30, neither of these directions is the "streamwise curvilinear fluid flow direction" of the reactor. Consequently, with respect, neither the "first direction" nor the "second direction" can be "parallel to the central axis of the reactor."

Similarly, the last line of the amended claim 40 reads "near the reactor outlet in at least one of the transverse directions." The reactor streamwise flow direction near the reactor outlet is generally parallel to the weighted mean flow "axis" of the reactor duct near the outlet, e.g., along the axis of the cylindrical reactor in Meenan. Consequently, both of "the transverse directions" "near the reactor outlet" are generally NOT parallel to the reactor axis near the reactor outlet. Consequently, Meenan does not teach the method of claim 40 or 76.

The Office Action states: "(d) controlling the spatial delivery of the reactant fluid (air) comprising reactant (air) into the reactor (10) in at least one of the transverse directions (e.g., by use of an air compressor) (see Meenan, column 2, lines 27-29);

With respect, Meenan makes no reference to "control", nor "uniform" nor "nonuniform" nor "homogeneous", nor "inhomogeneous", nor "distribution", nor "transverse", nor "ratio", nor "stoichiometric", nor "composition".

Meenan makes no reference to a "pump" and only mentions "compressor" as follows:

"The supply tubes 14 and 16 are connected to a source of pressurized fluid such as an air compressor."

Meenan's references to pressure are:

"The first conduit is connected to a source of pressurized fluid such as air and the second conduit is connected to a source of pressurized fuel such as gas."

". . .a combination gas and oil assisted pulverized fuel burning system generally designated by the reference numeral 10 that may be employed in conjunction with a high or low pressure furnace . . ."

"A multiple fuel burning system that may be employed in conjunction with a furnace includes a first annular tubular conduit connected to a source of pressurized fluid and a second annular conduit concentric with the first annular tubular conduit and coupled to a source of pressurized fuel."

"The system 10 further includes a second set of annular tubular conduits 18 defined by individual conduits 18A and 18B that are in fluid communication with supply tubes 20 and 22 that are connected to a source of pressurized gas such as a premix burner."

Meenan addresses and claims static blocking of fluid delivery from the manifolds to some pipes: "as illustrated in FIG. 1, the conduits 12A of set 12 are in fluid communication with supply tube 14 and fluid flows therethrough in the direction of the arrows but the conduits 12A are terminated by caps 13A that are mounted in depressions 24 in supply tubes 20 and 22, and thus, do not intersect tubes 20 and 22."

Thus, while Meenan mentions a compressor and delivery of pressurized fluid, he makes no mention of controlling or varying that pressure.

Meenan's only reference to "axial" is: "A first nozzle 40 is coaxial with and lies along the axis of the cylindrical combustion chamber 28."

Regarding “mix”, Meenan teaches: “Since one source of fuel used in the system 10 is pulverized material, proper mixture of gas and air throughout the length of the system 10 is necessary to insure proper combustion.” And “. . . supply tubes 20 and 22 that are connected to a source of pressurized gas such as a premix burner.” Premix burners commonly seek uniform premixing. These infer homogeneous and uniform mixing within the combustion chamber 28 as “necessary” “throughout the length” of system 10.

Regarding orifices or “jet openings 26” and “jet openings 30”, Meenan teaches:

“Around the inner periphery of each conduit 12A and 12B of the set of tubular conduits 12 are a series of jet openings 26 directed inwardly to the combustion chamber 28 to allow the passage of air into the chamber 28 along the entire length thereof. Similarly, each conduit 18A and 18B of the second set of tubular conduits 18 also includes a series of jet openings 30 extending along toward the combustion chamber 28 to allow the passage of gas from the set of tubular conduits 18 into the combustion chamber 28 along the entire longitudinal length thereof.” Applicant respectfully submits that Meenan appears to teach uniformly spaced peripheral jets 26, 30 and/or 47 oriented radially inward into the combustion chamber 28. Any apparent variation of orifice spacing shown in Fig. 2 appears to be the projection of uniform spacing onto an elevation drawing. Meenan's cylindrically symmetric configuration nominally provides axially uniform peripheral delivery gas and air to mix within the combustor. It also by implication provides axial liquid and pulverized fuel mixtures to mix with the air delivered along the combustor length and the reactor streamwise flow.

Meenan apparently gives no instruction on orientations other than radially oriented jets, nor any explicit description of spacing other than apparent uniform peripheral spacing in perforated cylindrical tubes uniformly spaced axially along and circumferentially around the combustor. It gives no instruction on the size distribution of orifices, nor on pressure control nor on differing penetrations of jets into the flow. Meenan only shows perforated tubes peripheral to the flow, with none distributed across the reactor flow.

With respect, Applicant does not see where Meenan teaches “controlling the spatial delivery of the reactant fluid … in at least one of the transverse directions” by configuring the orifices or by varying fluid flow, to affect the spatial delivery in “at least one of the transverse directions” distinct from the reactor streamwise flow.

Accordingly, applicant submits that Meenan does not anticipate the methods to obtain the non-uniform distributions transverse to the flow per revised Claim 40 or Claim 76.

The Office Action posits that one with ordinary skill in the art may combine the diluent addition system of Faulkner with the reactor of Meenan. Faulkner in Fig. 2, Fig. 8 and Fig. 4 shows some 21 air blast fuel injectors configured near the upstream end of an annular combustor. The injectors appear radially located about midway across the annulus. Faulkner in Fig. 2 shows use of upper and lower manifolds 110 and 112 with check valves 126 and 130 to halve the pressure difference between upper and lower nozzles 114.

Faulkner teaches: "water can be introduced into combustor 32 by way of the assist air passage 184 and primary air passage 186 in fuel injection nozzles 114 to reduce the nitrogen oxides emitted by engine 10." Faulkner expects that: "The swirling primary combustion air, along with that discharged from swirl vanes 174, atomizes the water, as well as the liquid fuel, forming a homogeneous mixture of the two liquids." "This promotes uniform mixing of the water and fuel and, as a result, a uniform distribution of the water in the combustor's primary combustion zone." Faulkner further expects "that an even and uniform distribution of the water is obtained", and that "efficient atomization and uniform mixing of the water, fuel, and combustion air is obtained even at low water to fuel flow ratios."

As shown in Table 1, Faulkner reports only a single parameter for temperature, NOx emissions, and water/fuel ratio for a given operating condition. Faulkner does not appear to address the radial or "profile" variations in air flow, fuel flow, air/fuel ratio, pressure, velocity, temperature, fuel evaporation, water evaporation, or NOx emissions across the annular combustor transverse to the reactor streamwise flow. Nor does Faulkner appear to address the substantial circumferential or "pattern" variation in the corresponding air flow, fuel flow, air/fuel ratio, pressure, velocity, temperature, fuel evaporation, water evaporation, or NOx emissions around the annular combustor transverse to the reactor streamwise flow due to the relatively small number of nozzles.

Furthermore, other than using a modest number of typical airblast nozzles with swirl, Faulkner does not appear to configure the delivery distribution of reactant, co-reactant or diluent (e.g., air, fuel, and liquid water) to address the variations in these radial and/or circumferential distributions transverse to the reactor streamline flow.

Faulkner's reported NOx emissions in Table 1 of 30 ppm at full load appear to be an order of magnitude higher than what might be achievable with the improved mixing of air, fuel, and water as taught by the present invention.

With respect, Applicant does not find that Faulkner teaches the methods of controlling spatial or temporal distributions of reactant, co-reactant, or diluent so as to control any of the transverse distributions cited in the claims, as shown in the applicant's disclosure. With neither Meenan nor Faulkner teaching now to control such spatial or temporal distributions, Even presuming that there were some apparent reason to combine the references as proposed in the Office Action, Applicant respectfully submits that one skilled in the art would not take the diluent delivery system of Faulkner in the method/reactor of Meenan to achieve the methods claimed in Claims 40 or 76. It is well settled by the courts that to establish prima facie obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974).

Claims 41-42, 45-46, 49-58 and 61-62 each depend, either directly or indirectly, from independent claim 40. These dependent claims are each separately patentable, but they are offered as patentable for at least the same reasons at their underlying independent base claim, the features of which are incorporated by reference.

With reference specifically to claim 45, this claims recites "modulating the spatial delivery of the reactant fluid into the reactor to reduce fluid pressure oscillation within the reactor." Meenan makes no mention of "modulating", or "varying", nor "controlling", nor "dynamically", nor "oscillations". Meenan's only mention to "pressure", is the generic observation that this: "combination gas and oil assisted pulverized fuel burning system generally designated by the reference numeral 10 that may be employed in conjunction with a high or low pressure furnace . . ."

While Meenan includes a compressor, applicant respectfully submits that Meenan does not teach or suggest: "modulating the spatial delivery of the reactant fluid into the reactor to reduce fluid pressure oscillation within the reactor" per claim 45. Faulkner does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Meenan relative to claim 45. Therefore, Applicant respectfully submits that claim 45 is further distinguished over Meenan and Faulkner, taken singly or in combination.

With reference to claim 46, this claims recites "modulating the spatial delivery of the diluent fluid into the reactor to reduce fluid pressure oscillation within the reactor." Faulkner address: "The height difference between the air assist and coolant lines or pigtails leading to the upper and lower fuel injection nozzles produces a considerable difference between the pressure on the coolant flowing to the upper and lower nozzles." It teaches: ". . . this problem can be solved by installing orifices and/or the use of a manifold system of the type shown in FIG. 2 in the pig tails. These reduce the difference in coolant flow to the upper and lower injection nozzles by increasing the coolant inlet pressure because mass flow is proportional to .DELTA.P/P ", etc. Consequently: "As long as the engine is running and fuel is being supplied to it through fuel lines 120 and 122, the pressure in line 122 is higher than that in lower manifold 112 by virtue of the pressure drop across check valve 126".

Conversely, Faulkner does not mention "modulating", or "dynamically", or "oscillation", or "noise", (nor "acoustic", nor "rumble", "growl", nor "hum", nor "whistle", nor "vibration".)

With respect, Applicant submits that Faulkner does not teach or suggest: ". . .modulating the spatial delivery of the diluent fluid into the reactor to reduce fluid pressure oscillation within the reactor" per claim 46. Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 46. Therefore, Applicant respectfully submits that claim 46 is further distinguished over Meenan and Faulkner, taken singly or in combination.

Claim 78 recites "controlling the delivery of diluent fluid and reactant fluid to the reactor to control the pressure within the reactor to within at least one specified safe operating bound of the co-reactant fluid delivery system." Faulkner's only reference to "control" is to air flow through the compressor: "Engine 10 includes a fifteen-stage axial flow compressor 12 with a radial-axial inlet 14. Inlet guide vanes 16 and stators 18 of the compressor are supported from compressor housing 20 with the guide vanes and the stators 18-1 through 18-5 of the first five stages being pivotally mounted so that they can be adjusted to control the flow of air through the compressor." It mentions reducing pressure difference of coolant delivery "by installing orifices and/or the use of a manifold system of the type shown in FIG. 2 in the pig tails."

Faulkner makes no mention of (compressor) "surge" or "choke". Faulkner does not mention or document the change in combustor pressure with load in Tables 1-6.

With respect, Applicant does not see how Faulkner teaches or suggests: ". . . controlling the delivery of diluent fluid and first reactant fluid to the reactor to control the pressure within the reactor to within the specified compressor surge boundaries above which pressure causes surge in the second reactant at least one specified safe operating bound of the co-reactant fluid delivery system." per Claim 78. Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 78. Therefore, Applicant respectfully submits that claim 78 is further distinguished over Meenan and Faulkner, taken singly or in combination.

Claim 53 recites "reactant delivery system and the diluent delivery system are configured to form interspersed reactable and non-reactable regions and further comprising providing a traversing region of reactable fluid traversing at least one of the non-reactable regions from one reactable region to another." Thus the "reactable" vs "non-reactable regions" are distinguished by "reactant delivery system and the diluent delivery system".

Meenan does not teach delivering diluent (e.g., water, steam or CO2) into the combustor. Meenan only shows delivery of reactant and co-reactant (air and gas, liquid fuel and/or pulverized fuel). Thus Meenan does not form "non-reactable regions" by the relative delivery of fuel and diluent as defined by claim 53. Furthermore, Meenan teaches: "In addition, the combustion process is maintained throughout the length of the combustion chamber 28 by the introduction of the air by the first set of conduits 12 and gas by the second set of conduits 18 extending along the full length of the combustion chamber 28." Thus Meenan appears to teach combustion methods that are explicitly "maintained" between air conduits 12 and gas conduits 18 "along the full length of the combustion chamber 28." This excludes formation of "non-reactable regions".

With respect therefore, Applicent submits that Meenan does not teach formation of "reactable vs non-reactable regions" due to configurations of reactant and diluent delivery. Accordingly, Meenan does not teach or suggest: "the reactant delivery system and the diluent delivery system are configured to form interspersed reactable and non-reactable regions and further comprising providing a traversing region of reactable fluid traversing at least one of the non-reactable regions from one reactable region to another" per claim 53. Faulkner does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Meenan

relative to claim 53. Therefore, Applicant respectfully submits that claim 53 is further distinguished over Meenan and Faulkner, taken singly or in combination.

Claim 56 recites "at least a portion of the diluent is delivered streamwise downstream of a rapid reaction front." As shown in Fig. 6, Faulkner discloses: "The swirling primary combustion air, along with that discharged from swirl vanes 174, atomizes the water, as well as the liquid fuel, forming a homogeneous mixture of the two liquids." The combustion or reaction front is downstream of this delivery location.

With respect, Faulkner teaches delivering water and fuel together. It does not teach or suggest delivering diluent (water or CO2) downstream of the combustion or reaction front. Accordingly, Faulkner does not teach: "wherein at least a portion of the diluent is delivered streamwise downstream of a rapid reaction front" of claim 56. Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 56. Therefore, Applicant respectfully submits that claim 56 is further distinguished over Meenan and Faulkner, taken singly or in combination.

Claim 57 recites "controlling the evaporation of a vaporizable portion of diluent by controlling a streamwise flow direction velocity distribution of the diluent as delivered from the diluent delivery system evaluated along at least a first transverse direction." Faulkner's only reference to evaporation is: "This is the approach I employ to reduce the NOx emissions of gas turbine engines. I do this by introducing a liquid coolant into the primary combustion zone of the turbine engine combustor. This reduces the flame temperature by evaporation of the coolant and because the coolant raises the average specific heat of the combustion mixture." Its only mention of "velocity" is to the air velocity: "This thin film of liquid fuel is contacted, and atomized, by the high velocity, swirling, primary combustion air . . ." and "dumped into the forward part of plenum 30, decreasing the flow velocity of the air. . . ." Faulkner apparently makes no mention of controlling the steamwise velocity of the diluent, nor of its transverse distribution.

Applicant respectfully submits that Faulkner does not teach or suggest: ". . .controlling the evaporation of a vaporizable portion of diluent by controlling a streamwise flow direction velocity distribution of the diluent as delivered from the diluent delivery system evaluated along at least a first transverse direction" per Claim 57. Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 57. Therefore,

Applicant respectfully submits that claim 57 is further distinguished over Meenan and Faulkner, taken singly or in combination.

Claim 58 recites "controlling the streamwise evaporation distance of the diluent in the reactor with respect to at least one of the transverse directions." Further to discussion of Claim 57, above, Faulkner makes no mention of "streamwise" nor of "distance" nor of "transverse" nor of how to control an "evaporation distance". Applicant respectfully submits that Faulkner does not teach: ". . .controlling the streamwise evaporation distance of the diluent in the reactor with respect to at least one of the transverse directions." Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 58. Therefore, Applicant respectfully submits that claim 58 is further distinguished over Meenan and Faulkner, taken singly or in combination.

Claim 61 recites "providing at least a portion of the reactor with coolant passages, cooling at least a portion of the reactor with diluent, and delivering at least a portion of the heated diluent to the reactor." As noted above, with respect, Applicant does not find that either Meenan nor Faulkner teach the methods of controlling spatial or temporal distributions of reactant, co-reactant, or diluent so as to control any of the transverse distributions cited in Claim 40. Applicant respectfully submits that one skilled in the art could not take the water delivery system of Faulkner with Meenan method of heating water, to achieve transverse distributions of claim 40 together with the diluent heating and delivery of claim 61. Therefore, Applicant respectfully submits that claim 61 is further distinguished over Meenan and Faulkner, taken singly or in combination.

Claim 62 recites "controlling the temperature of the product fluid exiting the reactor by controlling the total diluent enthalpy change comprising vaporizable diluent being delivered to the reactor." By comparison, Faulkner teaches:

"The efficacy of my novel technique for reducing the nitrogen oxides generated in a combustion process was demonstrated by tests in which a gas turbine engine of the type discussed above and identified by reference character 10 in the drawings was run as discussed above at a constant power turbine inlet temperature and over the range of operating conditions varying from no-load to full load and at a still higher load level (1935.degree. TRIT) that might be encountered under standby applications of the engine, for example. The water to fuel mass

flow ratios employed at the various load conditions and the reductions in NOx emissions that were obtained are tabulated along with related, relevant data in the following tables:"

From the tables of data Faulkner provides, it appears that he selects a nominal load level resulting in a nominal power turbine inlet temperature. For example, in Table 1, at nominal "Full Load", the Power Turbine inlet Temperature is about 1256 °F, with power of 8936 based on the air/fuel ratio at 0 Water/Fuel. Then Faulkner increments the water/fuel and appears to adjust the fuel to maintain the power turbine inlet temperature, e.g., to 1.60 Water/Fuel, with a power increase of 21.7% to 10872 BHP while keeping the power turbine inlet temperature at 1256°F. The burner efficiency only increases 0.5% from 99.45% to 99.95%. This can only be accomplished by a major increase in fuel delivery, e.g., by 21.1% more fuel (assuming the turbine efficiency remained the same).

In its examples Faulkner sets the water/fuel ratio and then adjusts the fuel to obtain the same temperature at the power turbine inlet temperature. Furthermore, the cooling effect of water is higher than that of air, and the pumping work to deliver water is much lower than that to deliver air. Consequently, Faulkner's method of controlling the Power Turbine Inlet Temperature with varying Water/Fuel ratios does NOT equate to controlling the temperature at the outlet of the combustor (or the inlet to the compressor turbine inlet temperature). Faulkner's combustor outlet temperature would be expected to vary with water/fuel ratio even when he keeps the Power Turbine Inlet Temperature the same per Faulkner's examples.

Faulkner's reference to constant "power turbine inlet temperature" does not teach how to control the mean compressor turbine inlet temperature, e.g., with respect to variations in air/fuel ratio and/or water/fuel ratio, nor to the transverse distribution of fluid delivery nor the transverse distributions of these ratios. Faulkner mentions one TRIT without definition. It apparently gives no indication whether this is a single temperature measurement, or a mean, mode or peak temperature. Faulkner apparently makes no mention of the transverse distribution near the combustor outlet of any of "the composition, temperature, pressure and velocity of the reaction product". Nor does Faulkner teach how to control the fluid spatial delivery to control those outlet transverse distributions.

Faulkner asserts without measurement or modeling that his invention: ". . .atomizes the water, as well as the liquid fuel, forming a homogeneous mixture of the two liquids." It asserts: "that an even and uniform distribution of the water is obtained" and "that efficient atomization

and uniform mixing of the water, fuel, and combustion air is obtained even at low water to fuel flow ratios". All this without any documentation of measurement of either the transverse distribution of the air flow or the water flow. These assertions are not supported by numerous reports in the literature of substantial variations in the transverse distribution of air flow, fuel distribution and temperature across the combustor.

With respect, Faulkner does not teach The claimed methods of using diluent (e.g., water) delivery to control the combustor outlet temperature while adjusting fuel delivery to control the power. Consequently, Faulkner does not teach "... controlling the temperature of the product fluid exiting the reactor by controlling the total diluent enthalpy change comprising vaporizable diluent being delivered to the reactor" per claim 62. Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 62. Therefore, Applicant respectfully submits that claim 62 is further distinguished over Meenan and Faulkner, taken singly or in combination.

Claims 79 and 80 both depend from claim 78, and incorporate the features of their underling base claim by reference. The Office Action does not allege that Meenan and Faulkner, even in combination, teaches or suggests the features of claim 78. Therefore, Applicant respectfully submits that the Office Action has not made a *prima facie* case of obviousness as to claims 79 and 80.

Notwithstanding, Claim 79 recites "controlling the temperature of the product fluid." Faulkner teaches: "This reduces the flame temperature in the combustor, thereby discouraging the formation of thermal NOx." "This is the approach I employ to reduce the NOx emissions of gas turbine engines. I do this by introducing a liquid coolant into the primary combustion zone of the turbine engine combustor. This reduces the flame temperature by evaporation of the coolant and because the coolant raises the average specific heat of the combustion mixture." "... the novel manifold system used to supply liquid fuel to the fuel injection nozzles of the gas turbine engines in which NOx emissions are reduced in accord with the principles of the present invention." "Primary among these is that introduction of the fuel in that manner enhances the efficiency of the coolant used to suppress thermal NOx formation." "... be equipped with a water injection system embodying the principles of the present invention to reduce the emission of nitrogen oxides from the engine." "I pointed out above that water can be introduced into combustor 32 by way of the assist air passage 184 and primary air passage 186 in fuel injection

nozzles 114 to reduce the nitrogen oxides emitted by engine 10." "Specifically, my invention is readily adaptable to a wide range of air blast fuel injection nozzles and, generally, to the reduction of NOx emissions in other settings, not just those involving gas turbine engines."

Faulkner's only reference to "control" or "adjust" is: "with the guide vanes and the stators 18-1 through 18-5 of the first five stages being pivotally mounted so that they can be adjusted to control the flow of air through the compressor." Furthermore, Faulkner does not use "maintain". Its only references to "limit" are regarding NOx, e.g. "One primary object of the present invention is to provide novel, improved gas turbine engines which are capable of meeting the limitations on NOx emissions imposed by existing and proposed legislation."

As noted above with respect to Claim 62, Faulkner's example is to set the water/fuel and adjust the fuel delivery to control the power turbine inlet temperature. Faulkner's only reference to air pressure is: "By increasing the size of the opening, the pressure on the atomization assist air required for good atomization of the fuel during light-off can be significantly reduced."

With respect, Faulkner does not teach controlling the pressure per Claim 78, nor does he teach "comprising controlling the temperature of the product fluid" per claim 79. Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 79. Therefore, Applicant respectfully submits that claim 79 is further distinguished over Meenan and Faulkner, taken singly or in combination.

Claim 80 recites "controlling the spatial distributions of the delivery of diluent fluid and of reactant fluid to the reactor wherein controlling the spatial distribution of pressure within the reactor in at least one of the transverse directions to within the at least one specified safe operating bound, and controlling the distribution of temperature of the product fluid in at least one of the transverse directions."

As noted above with respect to claim 79, Faulkner does not teach how to control the pressure nor does he teach how to control the temperature of the product fluid. Consequently, Faulkner does not teach how to controlling the spatial distribution of reactant or diluent, nor how to control the transverse distributions of pressure or of temperature of the product fluid per Claim 80. Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 80. Therefore, Applicant respectfully submits that claim 80 is further distinguished over Meenan and Faulkner, taken singly or in combination.

In light of the foregoing, Applicant respectfully submits that the rejection of claims 40-42,45,46 49-58, 61, 62, 76, and 78-80 has been obviated, and kindly requests favorable reconsideration and withdrawal thereof.

Claims 43, 44, 46 and 78 are rejected under 35 U.S.C. § 103(a) as being obvious over Meenan in view of Faulkner and U.S. Patent No. 5,349,811 to Stickler ("Stickler"). Applicant respectfully traverses the rejection.

Claim 43 recites "acoustically modulating the delivery of at least one of the delivered fluids thereby acoustically modulating the reacting fluid within the reactor." Claim 44 further recites "modulating the delivered fluid to at least 10 Hz." The Office Action offers Stickler as teaching these features.

Stickler makes no mention of "transverse", nor "spatial". Stickler observes: "The kinetic rate is dependent upon the fuel-to-air ratio, which generally varies in different areas of the combustion chamber, and the temperature in said areas." "The liquid fuel is introduced through nozzles or fuel injectors in the form of a fine spray. The air is compressed and introduced to the combustion chamber through a multiplicity of discrete jets and cooling passages. A minor amount of the air passes through the fuel nozzle to assist spray formation and distribution. A further amount of the air is introduced to mix with this spray as primary air to form an initial combustible mixture with the fuel."

However, aside from mentioning a plurality of nozzles and multiplicity of jets, Stickler does not appear to teach how to control the spatial delivery of fuel or air to achieve a desired transverse distribution of fuel or air/fuel ratio. Furthermore Stickler does not teach delivery of diluent, nor spatially controlling such diluent.

Stickler teaches "the introduction of an externally modulated, rapidly pulsed, oscillated or sinusoidal fuel flow delivery rate" such that the "primary effect of such mixing is rapid mixing of regions of hot combustion gases with cooler, typically higher oxygen content gases," "to constrain the extent of NOx formation, while allowing complete oxidation of the combustion gases." While affecting the local mixing and local temperature, and reducing NOx, Stickler does not appear to teach on controlling fuel, oxidant and diluent distribution to control "the transverse distribution of at least one of the composition, temperature, pressure and streamwise velocity of the product fluid, near the reactor outlet in at least one of the transverse directions" of Claim 40.

As observed above with respect to claims 40 and 76, neither Meenan nor Faulkner teach such transverse control.

Applicant respectfully submits that a person of ordinary skill in the art would not be able to take the method/reactor of Meenan with the diluent addition system of Faulkner with the pulsed fuel delivery of Stickler to configure a system conforming to Claim 40. Similarly, applying pulsed fuel injection does not thereby overcome the inadequacies of Meenan, Faulkner and Stickler to perform Claim 40 with the fluid modulation of Claim 43. Consequently, this combination would not satisfy the further limits of greater than 10 Hz of Claim 44.

Claim 46 recites "modulating the spatial delivery of the diluent fluid into the reactor to reduce fluid pressure oscillation within the reactor." Examiner posits that "Stickler discloses wherein the reactor pressure can be controlled by adjusting the delivery of reactant fluid to the reactor." With respect, Stickler teaches modulating fuel to improve mixing and reduce NOx. e.g., "can be employed to drive combustor pressure and flow oscillations", etc. In particular Stickler teaches how: "such factors are ideally chosen to result in air jet flow velocity approximately out of phase with the fuel flow, so that higher instantaneous fuel flow rate has corresponding lower instantaneous air flow rate, amplifying the effect of the fuel flow perturbation on the primary zone stoichiometry, its temperature, and consequently on the combustor pressure and flow oscillation,"

However, pressure oscillations in gas turbine combustors cause fatigue and have been known to cause the combustor to break free and destroy the downstream expander. Industry has worked strenuously to reduce such pressure oscillations.

Therefore, Stickler's teaches methods to increase or maximize combustor pressure oscillations, not reduce them. Stickler in light of Faulkner does not teach how to control pressure within compressor bounds, nor how to control the temperature distribution. Accordingly Stickler in light of Faulkner does not teach: "modulating the spatial delivery of the diluent fluid into the reactor to reduce fluid pressure oscillation within the reactor" per claim 46. Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Stickler and Faulkner relative to claim 46. Therefore, Applicant respectfully submits that claim 46 is further distinguished over Meenan, Faulkner and Stickler, taken singly or in any combination.

Claim 78 recites "controlling the delivery of diluent fluid and reactant fluid to the reactor to control the pressure within the reactor to within at least one specified safe operating bound of

the co-reactant fluid delivery system." Examiner posits that "Stickler discloses wherein the reactor pressure can be controlled by adjusting the delivery of reactant fluid to the reactor."

Stickler teaches modulating (pulsing) fuel to increase pressure oscillations. By contrast, the instant specification discloses *inter alia*, that control of pressure and temperature within the reactor to stay within safe operating bounds. See, e.g., [0678] – [0685].

Faulkner is concerned over compressor pressure at "light-off" and over the assist air pressure. Neither Stickler nor Faulkner makes mention of "choke" or "surge". Neither teaches or suggests controlling either fuel or diluent or the combination to control reactor pressure within safe boundaries to prevent compressor surge or reactor choke.

Applicant respectfully submits that Stickler with Faulkner do not teach: "controlling the delivery of diluent fluid and reactant fluid to the reactor to control the pressure within the reactor to within at least one specified safe operating bound of the co-reactant fluid delivery system" per claim 78.

Claims 47, 48, 59 and 60 are rejected under 35 U.S.C. § 103(a) as obvious over Meenan in view of Faulkner and U.S. Patent No. 4,176,637 to Cole ("Cole"). Applicant respectfully traverses the rejection.

As noted above, Applicant respectfully submits that Meenan teaches uniformly spaced peripheral jets oriented radially into the combustion chamber. He apparently gives no instruction on orientations other than radially oriented jets, nor any explicit description of spacing other than apparent uniform peripheral spacing in perforated cylindrical tubes uniformly spaced along the combustor. Meenan shows perforated tubes peripheral to the flow, but he gives no instruction on differing penetrations of jets into the flow. Nor does Meenan show perforated tubes distributed across the flow.

Referring to Fig. 2, Cole teaches: "A discharge nozzle 42a is provided at the end of the fuel conduit for aiding in mechanically forming a spray of fine mist or small fuel droplets which are discharged outwardly into the chamber at high velocity." Referring to Fig. 3, Cole teaches: "The fuel is induced into the stream of flowing air or other oxidizing agent by venturi action and in accordance with the present invention, a generally frustro-conically shaped, electrostatic charging electrode 56 in the form of a fine wire electrically conductive screen mesh is mounted downstream of the venturi nozzle 54." i.e., Cole teaches "mechanically forming a spray of fine mist or small fuel droplets", or "by venturi action". Furthermore, Cole does not refer to

"distribution", nor "transverse", nor "spatial", nor "homogeneous", nor "inhomogeneous", nor "uniformity", nor "pressure", nor "composition". Cole only mentions velocity of fuel droplets.

Applicant respectfully submits that Cole does not anticipate controlling: "one spatial distribution of each of the reactant fluid and the diluent fluid in at least one of the transverse directions controls the transverse distribution of at least one of the composition, temperature, pressure and streamwise velocity of the product fluid, near the reactor in at least one of the transverse directions" per claim 40.

Accordingly, Applicant respectfully submits that neither Meenan, Faulkner nor Cole teaches or suggests the methods to obtain the spatial distributions transverse to the flow of revised Claim 40 above, either singly or in combination. Claims 47 and 48 depend from claim 40 and incorporate its features by reference, and are submitted as patentably distinguished for at least the same reasons as their underlying independent base claim.

Claim 47 recites "electrically exciting at least a portion of the reaction product within the reactor." Claim 48 recites "modulating the reaction product to at least 2 kHz." As noted above, neither Meenan nor Faulkner satisfy the requirements of Claim 40. Furthermore, the Office Action observes that "Neither Meenan nor Faulkner discloses electrically exciting a portion of the hot fluid in the reactor to at least 2 kHz."

By contrast to the recited claims, Cole teaches: " . . .electrostatically charging fuel particles to provide better dispersion and mixing with an oxidizing agent such as air for subsequent combustion . . .". Similarly "As the fuel air mixture passes through the electrostatically charged screen, the fuel particles are electrostatically charged by physical contact with the electrode and the charged particles repel one another and are attracted by the opposite charge on the hot intake manifold or conduit leading to the combustion chambers of the engine."

Cole's only reference to hot gases is in the downstream expansion: "a turbine wheel having blades 48 which are driven by the hot gases to rotate as indicated by the arrow "A."" It appears that Cole uses the electrostatically charged screen to "provide better dispersion and mixing". The "subsequent combustion" appears to be downstream of Cole's apparatus. Consequently Cole's is teaching exciting a cool fluid, not a hot fluid.

Further, Cole makes no mention of "modulate", or "oscillate", or "vary" or "dynamic" or "frequency" or "Hz", or "pulsate", or "fluctuate", "acoustic", or "noise", or "pressure".

Conversely, Cole explicitly states: “If the source is AC, it may be rectified by a diode 30 into suitable DC potential”. “If the electrical source is AC current, a suitable rectifier circuit as described is provided to convert the AC to DC potential.” Similarly, Faulkner does not mention “modulate” or “oscillate”, “dynamic”, or “frequency”, or “Hz”, or “pulsate”, or “fluctuate”, or “acoustic”, or “noise”, or “pressure”. Faulkner's only mention of “control” is to configure the compressor guide vanes to: “to control the flow of air through the compressor.”

Accordingly, Applicant respectfully submits that neither Meenan or Cole anticipate the methods to “electrically exciting at least a portion of the hot fluid within the reactor” per claim 47. Further Applicant respectfully submits that Meenan in light of Faulkner and Cole do not teach “. . . modulating the combustion products to at least 2 kHz” per claim 48.

Turning to claims 59 and 60, claim 59 recites “configuring a high voltage power supply for at least one of the reactant delivery system or the diluent delivery system and generating a high voltage electric field within the reactor.” Claim 60 recites “modulating the high voltage electric fields.”

Cole teaches a centralized fuel nozzle 20a, 42a, or 54, with no indication of “controlling spatial distribution of fuel” “in at least one of the transverse directions”, or of “the composition, temperature, pressure and velocity of the reaction product, in at least one transverse direction near an outlet of the reactor . . .” Cole does not teach diluent delivery.

The proposed combination does not ameliorate their respective deficiencies. Therefore, the references, taken singly or in combination, do not teach or suggest all features recited in the claims. Accordingly, applicant respectfully submits that neither Meenan, Faulkner nor Cole, singly or in any combination, make obvious independent claim 40, and consequently neither dependent claims 59 or 60.

Faulkner provides a diluent delivery system, but does not teach providing a high voltage power supply for it. Meenan provides neither a diluent delivery system nor a high voltage power supply for said diluent delivery system. Only Cole describes a high voltage power supply and that only for a fuel system. Cole provides no diluent delivery system.

Applicant respectfully submits that Meenan in light of Faulkner and Cole do not teach Claim 76 with dependent claim 59 “configuring a high voltage power supply for at least one of the reactant delivery system or the diluent delivery system and generating a high voltage electric field within the reactor” per claim 59.

As noted above regarding Claim 48, Neither Cole nor Faulkner refer to modulating the electric field. Applicant respectfully submits that Meenan in light of Faulkner and Cole do not teach "modulating the high voltage electric fields" per Claim 60.

In light of the foregoing, Applicant respectfully submits that the rejection over Meenan in view of Faulkner and Cole has been obviated, and kindly requests favorable reconsideration and withdrawal.

Conclusion

In light of the foregoing, Applicant respectfully submits that all claims are patentable, and kindly solicits an early and favorable Notice of Allowability.

Respectfully submitted,

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